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Design of a gas-inducing impeller using Computational Fluid Dynamics

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Industrial bioreactors are commonly characterized by non-uniform substrate and microorganism concentration profiles due to poor mixing which subsequently results in low yield reaction systems. The impeller design is a critical component to promote the mixing inside the bioreactors.

In this work computational fluid dynamics (CFD) is used as a tool in order to model and improve the design and performance of a gas-inducing impeller from BIO-AQUA. BIO-AQUA is a Danish company specialized in developing wastewater treatment solutions for industry. The company has developed a fixed biological film reactor for aerobic decomposition of organic matter. The dispersion of air in the bioreactor is achieved by a gas-inducing impeller. A gas-inducing impeller provides both the agitation in the reactor and promotes the self-induction of air by reducing the pressure at the tip of the impeller. The rotational speed of the impeller leads to a decrease of the pressure due to the acceleration of the liquid around it. The rotation of the impeller generates a pressure difference inside the hollow shaft which promotes the transport of air from the opening at the top of the shaft into the liquid medium.[1]

The main goal of this computational investigation is to make a test design of the impeller developed BIO-AQUA. The original impeller designed is characterized by 30 blades and by a cover with a shape of a hat that sits on top of the impeller (see Figure 1). The “hat” has demonstrated to help on the dispersion of air throughout the tank. The test design will include 3 different designs which are based on the original impeller shape. The 3 new designs include different shapes of blade tips and different configurations of the “hat”.

The main result of this study is to find the most energy efficient design with the optimal air dispersion in the bioreactor.

References

[1] A.W. Patwardhan, J.B. Joshi, Design of Gas-Inducing Reactors, Ind. Eng. Chem. Res. 38 (1999) 49–80